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LETHAL TEMPERATURE LIMIT AND NECESSARY DEPTHS IN ARTIFICIAL GROWING OF YOUNG PIKE PERCH
[Letal'naya temperaturnaya granitsa i neobkhodimyye glubiny pri iskusstvennom vyrashchivanii molodi sudaka]

by

N. N. Zhdanova

Published in Trudy Azovskogo Naucho-Issledovatelskogo Instituta Rybnogo Khozyaystva [Transactions Azov Scientific Research Institute of Fisheries], No. 8, 1966, 79-88.

As is known, the embryonic and postembryonic growth of fish can occur normally, only within specific limits of variation of the water temperature. For successful commercial growing of young fish, these limits must be known.

Our studies in determination of the lethal temperature limit for pike perch larvae were conducted in 1957-1962, at the Uzyaksk Fish Hatchery, located in the Don delta, 4 km from the Gulf of Taganrog.

The total reservoir area is 714 hectares. Spawning ponds of 0.25 hectare each (32) occupy 8 hectares. The Southern nursery pond is 561 hectares and the Northern, 245 hectares.

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The terrain relief of the region is slightly rolling flat land, in which there are depressions, natural eriks (shallow channels in the delta) and narrow, closed ponds. The greatest depressions are located in the northern and western parts of the region, close to the river. The terrain with the greatest elevation is located in the center of the area, where the spawning ponds are located. The length of each spawning pond is 100 m and the width, 25 m.

Under the Don delta conditions, a rise in air temperature to 14-18°C and, then, a sharp decrease in it to 1.7-0.6°C, is observed almost every year in the spring. The daily amplitude of fluctuation reaches 18°C. The minimum water temperature in the spawning ponds on these days was between 4.4 and 5.5°C.

There are no data in the literature on the lethal temperature limit for Don pike perch larvae and fingerlings. There are only fragmentary and, moreover, contradictory indications of a number of authors, on the water temperature in the periods of spawning, egg growth, larva and fingerlings of pike perch.

According to the observations of N. I. Chugunova (1931), I. V. Tonkikh (1947), K. G. Konstantinov (1949), I. Ya. Syrovatskiy (1955) and S. G. Kryzhanovskiy (1949, 1953), pike perch spawning began in the Don, at a water temperature of 11-13°C. N. I. Syrovatskaya (1952) noted spawning of Don pike perch at 8.5-10°C.

M. D. Bilyy (1951, 1952) pointed out that pike perch spawning in the Dnepr stops upon reduction of the water temperature to 8-9°C.

V. S. Tanasiychuk, I. N. Vonokov and G. K. Nebol'sina (1957) observed pike perch spawning in the Volga-Caspian region, even at 4.5°C.

Massive pike perch spawning in the Don, according to the data of N. I. Syrovatskiy (1952), took place at 12-14°C, according to the observations of I. V. Tonkikh (1947) and K. G. Konstantinov (1949), at 14-15°C, and N. I. Chugunova (1931) and S. G. Kruzhanovskiy (1949, 1953) noted pike perch spawning at 18-20°C.

Investigators have noted the end of pike perch spawning at 21-23°C.

The temperatures, at which the growth of eggs, larvae and fingerlings of pike perch has been observed, are presented in Tables 1 and 2.

It is seen from the material presented above that perch pike spawning in different climatic zones and in the same region takes place at different water temperatures in individual years. In the Volga-Caspian region, pike perch can spawn at a lower water temperature (4.5-6.0°), than under the Don conditions, where its spawning stops, upon reduction of the water temperature to 8-9°.

It should also be noted that, although the temperature range in the period from the start to the end of pike-perch spawning in the Don is large and varies from 8.5 to 23° (14.5°), massive spawning of it takes place within quite narrow temperature limits: 14 (12)-20°.

Consequently, the 12-20° temperature range apparently is the optimum, within which pike perch spawning proceeds at the greatest rate, under the Don conditions. This conclusion is in agreement with our observations: massive pike perch spawning in the Uzyaksk hatchery ponds takes place at a temperature of 13.5-16.8° (see Table 2).

It is characteristic, that the course of spawning and hatching of larvae has taken place in direct relationship to water temperature. Thus, hatching began in 1958 on 27 April, at 17°C. The water temperature

TABLE 1. WATER TEMPERATURE IN PIKE PERCH SPAWING PERIOD

a Район исследования	b Температура воды, град			f Автор
	c минимальная	d максимальная	e в период массового нереста	
g Дон, дельта	11—12	22—23	— h	К. Г. Константинов 1949
i То же	—	—	14—15 j	И. В. Тонких, 1947
»	12	—	18—19 k	С. Г. Крыжановский, 1949, 1953
l Дон, займища	12—12.5	—	19 m	Н. И. Чугунова, 1931
i То же	8.5—9	—	12—13 n	Н. И. Суровацкая, 1952, 1955
»	11—12	22—23	— o	И. Я. Суровацкий, 1955
p Волга, дельта	6	—	11.6 q	В. С. Танасийчук, И. К. Воронков, 1955
i То же	4.5	20—22	6.8* s 13—16	В. С. Танасийчук, И. К. Воронков, Г. К. Небольсина, 1957
t Кубань	12—12.5	—	18—19 m	Н. И. Чугунова, 1931
u Днепр	7—8	20	10—18 v	М. А. Полтавчук, 1963
i То же	11	—	— w	Н. Д. Билый, 1951
x Дунай	8—9	—	12—15 y	Ф. Г. Мартышев, 1958
z Озера Венгрии	10—12	—	— a'	В. О. Клер, 1912
b' Озера Финляндии	14	26	19.1	Brofeldt, 1920

*6-8° is the optimum temperature at the start of spawning, 13-16°, at the end.

Key: a. study region
b. water temperature, °
c. minimum
d. maximum
e. in period of massive spawning
f. author
g. Don, delta
h. K. G. Konstantinov
i. same
j. I. V. Tonkikh
k. S. G. Kruzhanovskiy
l. Don, flook plain
m. N. I. Chugunova
n. N. I. Surovatskaya
o. I. Ya. Surovatskiy
p. Volga, delta
q. V. S. Tanasiychuk
r. I. K. Vonokov
s. G. K. Nebol'sina
t. Kuban'
u. Dnepr
v. M. A. Poltavchuk
w. M. D. Bilyy
x. Danube
y. F. G. Martyshev
z. lakes of Hungary
a'. V.J. Kler
b'. lakes of Finland

[Translator's note: commas in tabulated figures are equivalent to decimal points.]

TABLE 2. WATER TEMPERATURE IN PERIOD OF SPAWNING AND HATCHING OF PIKE PERCH LARVAE IN UZYAKSK HATCHERY SPAWNING PONDS

a Год наблюдений	b Нерест						c Выклев					
	d дата			e температура воды, С			d дата			e температура воды, °С		
	f начало	g конец	h массовый	f начало	g конец	h массовый	f начало	g конец	h массовый	f начало	g конец	h массовый
1958	19/IV	10/V	21—23/IV 26/IV—1/V	10,2	18,8	13,5	27/IV	15/V	27/IV 3—5/V	17,0	19,0	17,0
1959	14/IV	4/V	14/IV 22—25/IV 1—4/V	13,9	19,2	13,9 14,6 16,2	19/IV	15/V	16—23/IV 30/IV 1—5/V	16,8	17,0	16,8 17,5
1960	19/IV	2/V	23—25/IV	14,4	16,8	14,1	26/IV	4/V	27—29/IV	14,3	17,5	15,0—18,0
1961	18/IV	9/V	18/IV 25—26/IV 1—5/V	14,4	19,0	15,0	21/IV	10/V	27—28/IV	14,1	18,4	14,0
1962	9/IV	28/IV	16/IV 20/IV	13,4	19,1	14,3 16,8	21/IV	7/V	25—29/IV	14,6	17,9	16,0

Key: a. year of observation
b. spawning
c. hatching
d. date
e. water temperature, °C
f. start
g. end
h. massive

[Translator's note: Roman numerals designate the month.]

decreased to 13°C on 28 April, and hatching almost stopped. In the first days of May, with a rise in temperature to 16-18°C, the hatching rate increases, reaching a maximum by 3-5 May.

The temperature affected, not only the rate of embryogenesis, but its qualitative aspects.

As is known, a temporary decrease in water temperature to 0-8.5°C, during the time of growth of the eggs of spring-spawning fish causes general and specific changes in the normal process of development of the embryos, leading to the death of the latter (S. G. Kruzhanovskiy, 1949; G. N. Musatova and S. K. Troitskiy, 1951; S. G. Kruzhanovskiy, N. N. Disler and Ye. N. Smirnova, 1953; I. V. Tonkikh and P. M. Konovalov, 1940).

Under the Uzyaksk hatchery conditions, in 1959 and 1961, after high spawning temperatures (13-15°C), a sharp temperature decrease to 6-8°C took place at the beginning of April, as a result of which, according to the data of O. D. Romanycheva,[1] 40-55% of the pike perch eggs died and, in the developing roe, up to 83% of the embryos were abnormal. According to our data, 54% of the larvae dying out were abnormal, as a consequence of which, their mortality increased in the next 2-3 days (Table 3).

The decrease in water temperature in the ponds to 4.5-6° led, not only to massive death of the roe and the appearance of abnormal larvae, but to a 5-7 fold decrease in number of normally developed larvae (4.4-7.0 mm) in the catches.

Of the larvae dying out, the ratio of body and tail length was disrupted, and it was 1:2.5 (normal, 1:1.5) (S. G. Kryzhanovskiy, 1953),

[1]Romanycheva, O. D., this collection.

TABLE 3. NUMBER OF ABNORMAL PIKE PERCH LARVAE IN UZYAKSK HATCHERY SPAWNING PONDS IN 1959

a. Дата	b. Количество исследованных личинок, шт.	c. Процент уродливых личинок
20/IV	101	51.4
21—25/IV	704	16.6
27—30/IV	138	6.5
2—5/V	212	4.7

Key: a. date
b. number of larvae studied
c. percent abnormal larvae

the fin fold was very small and, it was completely absent or developed disproportionately (projections) in some parts of the body, and the eyes of the larvae were destroyed. Larvae were most often found with protrusion of the yolk sac, abnormal location of the fat drop (in the region of the anal opening, thoracic fins, etc.) and convulsively constricted bodies. Larvae with such changes in body structure were observed in tests, after a sharp decrease in temperature.

Our tests to find the lethal temperature limit for pike perch larvae were performed, according to the method of V. V. Veselov (1962).

The experiments were conducted in two variants. The first consisted of study of the reactions of 4.5-5.8 mm long larvae to a gradual increase in temperature. A thermostat with a heat regulator was used for this purpose. Larvae, numbering 13-15, were transferred to glass jars (200 cm^3), with well aerated water, and were placed in the thermostat. The original (initial) temperature for the test was the temperature of the water in the ponds, before the start of the experiment. The temperature in the thermostat was gradually increased by 1-2° and was set for a given time, by means of the heat regulator. Observations of the condition of the larvae were carried out systematically.

The second area of the experiments was the study of reactions of the larvae to a sudden change in temperature. For this, pike perch were transferred from water at the normal temperature, to which they were accustomed, to a series of glass jars with water (200 cm^3). The water temperature was 1-2°C higher in each succeeding jar, than in the preceding, and the entire series represented a range from normal temperature to 32°C.

Water taken from the pond was poured into all the jars. Then, different amounts of hot water was added to each of them, in order to achieve the temperature gradations indicated above. The water was aerated. Thirteen-fifteen larvae were transferred to each of the jars, and their condition was followed for a period of an hour.

In study of the effect of low temperatures on pike perch larvae, the tests were set up according to the same scheme, but a refrigerator was used, instead of the thermostat. In study of the behavior of the larvae towards the sharp decrease in temperature, water from the pond was diluted with cold water. Eleven series of tests were performed, to ascertain the behavior of pike perch larvae towards an increase in temperature and 7 series, to ascertain the reaction of the larvae to a decrease in temperature.

Temperature Increase

As a result of the tests performed, it was determined that, with a gradual increase of temperature from 18 to 25-26°C, the activity of the larvae decreased, and their movements slowed down. At 26°C, some of them went into shock and then died. The shock state of all test pike perch was displayed at 30°C; they began to die at 32°C.

A sudden transfer of larvae from water at a temperature of 18°C to water at a temperature of 25°C led to a slowing down of movement of the larvae and even complete cessation of it. With change in temperature from 18 to 28°C, shock set in; with variation of the temperature from 18 to 30°C, the larvae died.

Thus, the upper lethal temperature limit for hatching pike perch larvae (4.5-5.8 mm, stage A_1A_2, according to V. V. Vasnetsov) is from 30 to 32°C. But, their activity decreased sharply at 26°C.

Temperature Decrease

With a gradual decrease in temperature (from 18°C), the first deviation from normal behavior of pike perch larvae (slowing of movements) was noted at 11°C; a temperature decrease to 6.5°C caused shock in them, and the larvae turned over on the side. Holding the larvae at 6.0°C for a period of 35 sec led to their death. In this case, their bodies were convulsively constricted and their cords bent. We caught pike perch with such changes in body structure in the spawning ponds on the Uzyaksk hatchery, after a decrease in water temperature.

A sharp 3°C reduction in water temperature in the test (from 17°C) led to a brief change in behavior of the larvae, and to slowing down of their movement. Variation of temperature from 17° to 8°C (a 9°C drop) causes convulsions of the larvae, and shock sets in.

Thus, the lower lethal temperature limit for Don pike perch larvae is 6.0-6.5°C. However, at 10°C, the behavior of the pike perch changes abruptly: movements slow down and convulsions appear. A sharp decrease in water temperature from 17 to 7°C causes death of the larvae.

It follows from the data presented that, in the period of hatching and growth of pike perch larvae, a drop of water temperature below 10°C is not desirable, and a sharp change in it (a 10°C drop) and a decrease to 6.0-6.5°C is not permissible.

The thermal regime is most closely connected with pond depth: the less the depth, the greater the amplitude of fluctuation of the temperature.

There are contradictory data in the literature, on the depths of pike perch spawning places.

According to the data of N. I. Chugunova (1931), I. Ya. Syrovatskiy (1940), A. Ye. Gorodnichiy (1955), K. G. Konstantinov (1949), and N. I. Syrovatskaya (1953), pike perch deposit eggs at a shallow depth, 0.2-0.7 m.

I. V. Tonkikh (1947) and I. Ya. Syravatskiy (1955) observed spawning of pike perch in the Don delta both at shallow depths (0.3-0.5 m), in the absence of water current, and at great depths, 0.7-1.0 m, with flow of the water.

V. S. Tanasiychuk (1955) also noted massive egg deposition of pike perch at a depth of 1.3-1.6 m, in running sections of the Volga delta.

M. D. Bilyy (1951, 1952), in tests on the Ol'shanka River (a tributary of the Dnepr), determined that pike perch spawn at a depth of from 0.5 to 3.0 m, but that the greatest number of nests was at a depth of 2.0-3.0 m.

The authors do not always introduce data on other abiotic factors of the environment (oxygen, temperature, wind conditions, etc.), and little material on survival of the eggs at different depths. This does not allow understanding of the reasons for selection of egg deposition locations of the pike perch.

The depths in the spawning ponds of the Uzyaksk hatchery were the following, with maximum filling with water (Table 4).

TABLE 4. DEPTHS IN UZYAKSK HATCHERY SPAWNING PONDS

a Глубина, см	b Площадь		c Максимальная глубина, см	d Общая площадь нерестовика, га
	e га	%		
f От 0 до 40	0,06	24	110	0,25
» 41 » 80	0,14	56	—	—
» 81 » 110	0,05	20	—	—

Key: a. depth, cm
b. area
c. maximum depth, cm
d. total spawning pond area, hectare
e. hectares
f. from
g. to

The death of eggs in nests, located in shallows, with a sharp drop in water temperature (to 7°C), was greater than in nests, located in deep water sections (Table 5).

TABLE 5. DEATH OF PIKE PERCH EGGS IN NESTS LOCATED AT DIFFERENT DEPTHS IN SPAWNING PONDS (23 April 1959)

a № гнезда	b Глубина нахождения гнезда, см	c Отход икры, %
1	16	18
2	42	9
9	97	4

Key: a. nest number
b. depth of nest, cm
c. death of eggs, %

Under downstream Don conditions, with extremely changeable thermal and wind conditions in the spring period, the death of pike perch eggs in shallow spawning ponds, according to the observations of O. D. Romanycheva, was 50-100% (1961).

Thus, the existing spawning ponds, with depths of from 40 to 80 cm in the greater part of the area, do not ensure normal growth of the eggs and larvae of the pike perch.

Our observations (N. N. Zhdanova, A. G. Krylova, M. K. Spichak, 1961) showed that hatched pike perch larvae (4.5 mm) keep to the nests. Pike

perch 5.2-6.2 mm in size are caught over the entire spawning pond and over the entire depth of the water, in calm weather. In a strong wind, the the larvae move to protected sections, and keep to depths of 70-110 cm (Table 6) at the dike, using only 10% of the entire area of the spawning pond.

TABLE 6. DEPTH DISTRIBUTION OF PIKE PERCH LARVAE IN SPAWNING POND (caught in one sweep of a hand net)

a Глубина, см	b Количество пойманных личинок	
	c в безветренные дни	d при ветре
10	20	0
40	160	0
48	60	10
71	164	500
100	10	5000
110	18	470

Key: a. depth, cm
b. number of larvae caught
c. on windless days
d. in wind

It was interesting to follow the distribution of pike perch fingerlings in the nursery ponds.

The depths of the nursery ponds are presented in Table 7.

From the spawning ponds, the pike perch larvae (1958, 1960) entered the deep eriks of the nursery pond, devoid of thick weeds, and the reaches adjacent to them, up to 70 cm deep, with sparse undergrowth of young reeds, creating "still zones," the favorite habitats of small plankton organisms, on which the pike perch fed. Thirty-forty pike perch larvae were caught in one throw of a hand net, in such places.

In other years (1959), when, because of failure in operation of the pumping station, the nursery ponds were not filled to the planned marks, and the larvae entered reaches 20-50 cm deep, covered with the remains of soft and tough meadow vegetation, with abundance of hairweed, growing vigorously at this time. The strong east winds prevailing in May interfered with movement of the larvae to great depths, carried them from place to

TABLE 7. DEPTHS OF NURSERY PONDS OF UZYAKSK HATCHERY
(data of Gidrorybproyekt)

a. Глубина, см	b. Площадь водоемов				c. Средняя глубина водоемов, см		d. Максимальная глубина водоемов, см	
	e. Северный		f. Южный		e. Северный	f. Южный	e. Северный	f. Южный
	га	%	га	%				
От 0 до 25	25,7	10,5	78,5	14,0	65	55	130	2,03
» 26 » 50	45,8	18,7	131,8	23,6	—	—	—	—
» 51 » 75	59,0	24,1	255,4	47,2	—	—	—	—
» 76 » 100	97,3	39,7	73,5	13,1	—	—	—	—
j. Больше 100	17,2	7,0	9,6	1,7	—	—	—	—
k. Всего	245	100	571	100	—	—	—	—

Key: a. depth, cm
b. pond area
c. average pond depth, cm
d. maximum pond depth, cm
e. northern
f. southern
g. hectare
h. from
i. to
j. over
k. total

place and muddied the water with silty soil (water turbidity increased to 100-120 mg/ℓ). The death of pike perch larvae in such shallow sections was high. Thus, on 5 May 1959, 5-8 pike perch were caught in a stretch of water, only 1-2 on 6 May, and there were no larvae at all on 7 May.

Pike perch 6.7-10.5 mm in size, changing to active feeding (stage C_1-C_2), live mainly in places 90-100 cm deep.

Larger pike perch (10-15 mm, 8-30 mg) transfer to deeper, slightly overgrown places in the pond, and they stay in shoals 30-40 cm below the surface of the water, in sections over a meter deep.

In subsequent growth stages, in connection with change in morphology of the pike perch and the nature of its nutrition, its habitat changes. Pike perch 14.0-22.0 mm long, weighing 30-140 mg, transfer to the eriks

and collectors, the deepest (1.5-2.5 m) places in the ponds, where they feed on bottom-dwelling organisms, mysids (stage E).

Under natural conditions in the Don flood plains (V. V. Vasnetsov, 1957), pike perch of this length kept to a depth of 4-6 m, where there was no overheating of the water or oxygen shortage.

Thus, to judge by the distribution of pike perch in the nursery ponds in 1957-1961, it can be stated that its larvae and young keep mainly to depths of 60-70 cm and more and that shallow water (from 0 to 60 cm) is almost not used by them for grazing.

This conclusion is confirmed by the data of I. Ya. Syrovatskiy, 1940, I. I. Kuznetsova, 1955, 1958, V. V. Vasnetsov, 1957, P. D. Nikol'skiy, 1956, A. Ye. Gorodnichiy, 1955, V. S. Tanasiychuk, 1955 and G. G. Tamanskaya, 1960, 1961, observing the distribution and behavior of pike perch under the natural conditions of the Don, Volga, Kuban' and in hatcheries.

Conclusions

1. Pike perch are fish with high requirements, with respect to pond thermal conditions, in the periods of spawning, egg development, larvae and young. Massive spawning of the pike perch takes place under the Don conditions, at a temperature of 12 (14)-20°. Temperatures of 14-23° are the optimum for development of the pike perch larvae, aged 1-7 days. The upper lethal temperature for 4.5-5.8 mm long larvae is 30-32° and the lower is 6.0-6.5°. Young pike perch, 12-30 mm long (22-35 days) developed normally in the ponds, at temperatures of 14-26°, and a temperature increase to 30° led to death of the young.

A sharp change in water temperature from 13-15° to 4.5-6° led to great death of pike perch eggs in the nests, and to enormous appearance of abnormal embryos in the developing roe. Up to 54% of the hatching larvae were abnormal, as a consequence of which their mortality in the next 2-3 days increased. The number of normally developed larvae (4.4-7.0 mm) in the ponds decreased 5-7 fold in the catches. Therefore, in ponds in which pike perch are grown, sharp changes in water temperature cannot be permitted.

Pond depth did not have a significant effect on development of pike perch eggs, under favorable conditions (the absence of sharp temperature decreases, strong winds, etc.). In bad weather, greater depths decrease the harmful effect of various factors, not only on the developing eggs, but on the pike perch larvae.

Distribution of the pike perch (5.2-32 mm) in the breeding ponds in 1957-1962 shows that the young keep mainly to places with depths of over 60 cm, and that shallow areas (from 1 to 60 cm) are hardly used by the pike perch for grazing.

The existing nursery ponds, with average depths of 0.55-0.66 m, in which 50-70% of the area is depths of from 0 to 60 cm, do not meet the do not meet the requirements of the biology of young pike perch.

2. Subsequently, in the construction of hatcheries for growing young pike perch, with consideration of their biology, there must be deep water spawning and nursery ponds.

The depths of spawning ponds of 0.2-0.3 hectares in area must be on the order of 1.5-2.0 m. With sharp temperature fluctuations, the water level in the spawning ponds must be increased, and the depth brought up to 2.0-2.5 m.

However, in the Don delta region, which is distinguished by extremely changeable thermal and wind regimes, the factory method of incubation of roe or incubation of roe in drizzle chambers is more promising (Ye. Voynarovich, 1959).

3. In the nursery ponds, the shallow water areas, unused by the pike perch for grazing, must be reduced. There must be sections with depths of over a meter in the greater part of the pond areas (60%, and not 1.7-7.0%, as at present). Moreover, places with depths up to 2.5-3.0 m are necessary, in which the bulk of the young pike perch stay on hot days.

Bibliography

1. Bilyy, M. D., "Study of spawning and production of fertile pike perch roe, by means of artificial nests," Vtoraya ekologicheskaya konferentsiya po probleme "Massovyye razmnozheniya zhivotnykh i ikh prognozy" [Second Ecological Conference on the Problem of "Massive Reproduction of Animals and Its Prognosis"], Kiev, 1951.

2. Bilyy, M. D., "Spawning of Dnepr pike perch and its egg production, by means of artificial nests," Trudy instituta gidrobiologii AN USSR, issue 27 (1952).

3. Vasnetsov, V. V., Ye. F. Yeremeyeva, N. O. Lange, Ye. N. Dmitriyeva, and R. Ya. Braginskaya, "Stages of development of commercial semi-migratory fish of the Volga and Don — bream, sazan, Caspian roach, roach and pike perch," Trudy IMZh, issue 16, AN SSSR Press (1957).

4. Veselov, V. V., "Simplest methods of study of certain reflexes of fish larvae and fingerlings," Rukovodstvo po metodike issledovaniy fiziologii ryb [Manual on Methods of Study of the Physiology of Fish], AN SSSR Press, 1962.

5. Voynarovich, Ye., "Technique of incubation of pike perch roe in drizzle chambers," Seriya "Rybnoy promyshlennosti za rubezhom" [Series "The Fish Industry Abroad"], Moscow, 1959.

6. Gorodnichiy, A. Ye., "Data on the biology of the young of early stages of the pike perch and bream in the Gulf of Taganrog," Trudy Azcher-NIRO 16, Simferopol' (1955).

7. Derzhavin, A. N., "Sevruga (Acipenser stellatus Pallas): biological traits," Izvestiya Bakinskoy ikhtiologicheskoy laboratorii 1, Baku (1922).

8. Zhdanova, N. N., A. G. Krylova and M. K. Spichak, "The effect of wind on growing conditions of young pike perch in the Don River," Rybnoye khozyaystvo, 8 (1961).

9. Konstantinov, K. G., "Data on the biology of reproduction of the pike perch," DAN SSSR 67(6) (1949).

10. Kryzhanovskiy, S. G., "Ecological-morphological regularities of development of carp, loach and sheat fish," Trudy IMZh 1, AN SSSR Press (1949).

11. Kryzhanovskiy, S. G., N. N. Dislev and Ye. N. Smirnova, "Ecological-morphological patterns of development of perch," Trudy IMZh 10, AN SSSR Press (1953).

12. Kler, V. O., Razvitie sudaka v Vengrii i vozmozhnost' ego kul'tivirovaniya v presnkh limanakh Bessarabii [Growth of Pike Perch in Hungary and Possibility of its Cultivation in the Fresh Water Estuaries of Bessarabia], Kishinev, 1912.

13. Kuznetsova, I. I., Razvedeniye sudaka v nerestovo-vyrastnykh khozyaystvakh del'ty Volgi [Pike Perch Breeding in the Spawning-Breeding Hatcheries of the Volga Delta], Pishchepromizdat Press, 1955.

14. Musatova, G. N., and S. K. Troitskiy, "Length of incubation of roe and size of larvae of pike perch and roach at the time of hatching," Rybnoye khozyaystvo (4)(1951).

15. Martyshev, F. G., Prudovoye rybovodstvo [Pond Fishery], Sovetskaya nauka, Moscow, 1958.

16. Nikol'skiy, P. D., Opyt sovmestnogo vyrashchivaniya molodi sudaka i leshcha [Experience in Combined Cultivation of Pike Perch and Bream Young], Pishchepromizdat Press, 1956.

17. Syrovatskiy, I. Ya., "The effect of salinization on reproduction of fresh water and semi-transient fish in the Veselovskiy reservoir," Zoologicheskiy Zhurnal 34(4) (1955).

18. Syrovatskiy, I. Ya., "Materials on the ecology of reproduction of bream and pike perch in the Don," Raboty Dono-Kubanskoy nauchno-rybokhozyaystvennoy stantsii (6) (1940).

19. Syrovatskiy, I. Ya., and I. V. Tonkikh, "Effect of salinization on fish spawning in the Don delta," Doklady VNIRO (7) (1947).

20. Syrovatskaya, N. I., "Materials on the descent and growth of young Don fish," Trudy AzcherNIRO, 16.

21. Syrovatskaya, N. I., "Materials on the biological foundation of reproduction of bream and pike perch under Volga-Don conditions," Uchenyye zapiski Rostovskogo Gosudarstvennogo universiteta. Special issue (1952).

22. Tanasiychuk, V. S., "The biology of pike perch fingerlings of the Northern Caspian," Voprosy ikhtiologii (3) (1955).

23. Tanasiychuk, V. S., and I. K. Vonokov, "Spawning of the pike perch in the Volga lowlands," Zool. zhurn. 34(5) (1955).

24. Tanasiychuk, V. S., I. K. Vonokov and G. K. Nebol'sina, "Reproduction biology of the Volga pike perch, as a basis for measures in reproduction of supplies of it," Tr. soveshchaniya po rybovodstvy [Proceedings, Conference on Pisiculture], Moscow, 1957.

25. Tonkikh, I. V., "Fish spawning in the Don delta," Doklady VNIRO (7) (1947).

26. Chugunova, N. I., "Biology of the pike perch of the Sea of Azov," Trudy Azovsko-Chernomorskoy ekspeditsii, 14, Moscow (1931).

27. Cherfas, B. I., Rybovodstvo v yestestvennykh vodoyemakh [Fish Breeding in Natural Reservoirs], Pishchepromizdat Press, 1956.

28. Brafeldt, "Evois Fishery Research Station," Finlands fiskerie [Fisheries of Finland], Fishery Administration, Helsingfors, 1920.